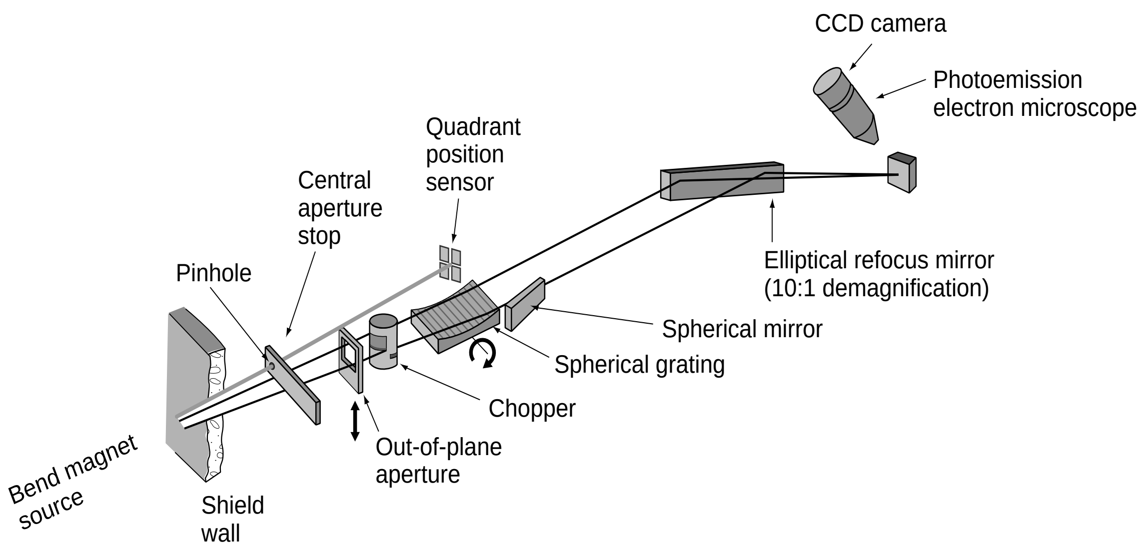
X-Ray Photoemission Electron Microscope (X-PEEM) • Branchline 7.3.1.1

Berkeley Lab • University of California

Branchline Specifications

Photon Energy Range (eV)	Photon Flux (photons/s/0.1%BW)	Spectral Resolution (E/ΔE)	Polarization	Spatial Resolution (nm)	Samples	Availability
175–1500	3×10^{12} (at 800 eV in 30 × 30 μm spot)	1800 (at 800 eV)	Linear or Circular	20 (NEXAFS) 50 (XMCD)	UHV-Compatible Solids (up to 1 cm^2 in area)	NOW



Schematic layout of Branchline 7.3.1.1.

Beamline 7.3.1 has two branches co-developed with industrial partners. The x-ray photoemission electron microscope (X-PEEM) on Branchline 7.3.1.1 was developed with the IBM Almaden Research Center. It is designed specifically both for near-edge x-ray absorption fine-structure spectroscopy (NEXAFS) and x-ray magnetic circular dichroism (XMCD) and x-ray magnetic linear dichroism (XMLD) spectroscopy of microscopic areas on sample surfaces and for imaging. A separate data sheet describes Branchline 7.3.1.2 for spatially resolved x-ray photoelectron spectroscopy (microXPS), which operates in parallel with the X-PEEM branch.

The instrument operates over the photon energy range from 175 to 1500 eV with a spectral resolving power between 1000 and 2000 that is adequate for most imaging investigations. A spherical-grating monochromator (SGM) with no entrance slit and a low line-density grating (200 lines/mm) is used to obtain high throughput while still achieving the desired spectral resolution. The radiation source—the center magnet in the triple-bend achromat lattice of the ALS storage ring—is focused to a spot

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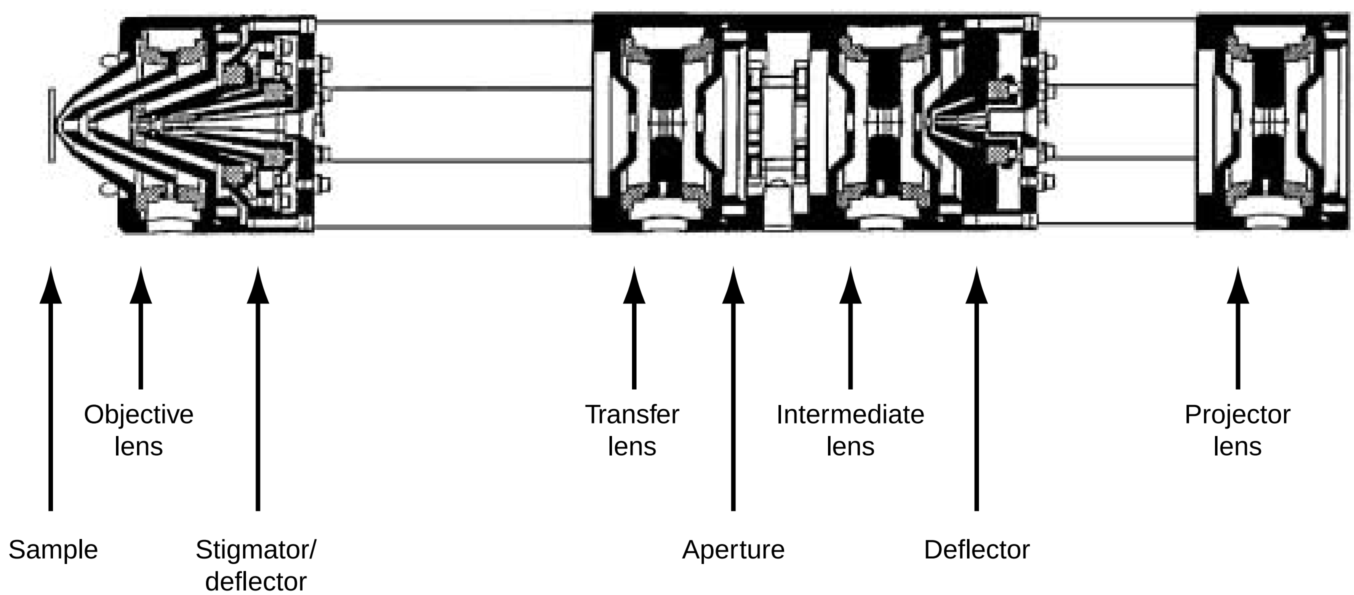
less than 30 × 30 µm at the sample. Circularly polarized radiation is obtainable by means of a movable aperture that selects light from above or below the horizontal plane.

The electrostatic optical system of the microscope images secondary electrons at high magnification onto a phosphor and CCD camera by means of a three-element high-voltage (25 kV) objective lens, a transfer lens, an intermediate lens, and a projector lens. The combination of high-voltage operation, a small angle-defining aperture (12 µm), and stable mechanical construction leads to a resolution of about 20 nm for elemental contrast imaging and 50 nm for XMCD imaging. With electron detection, the samples must be conductive, reasonably flat, UHV-compatible solids.

A flux in the image area greater than 10^{12} photons/s permits real-time studies of elemental, chemical, magnetic, and topographical properties of materials. The yield of electrons over the entire illuminated area is imaged at high magnification, and, by recording frames sequentially with an incrementally increasing photon energy, one can produce a NEXAFS spectrum for each image point. The same procedure using circularly polarized light yields magnetic images and XMCD spectra and using linearly polarized light yields XMLD images and spectra.

The X-PEEM is equipped with an automated sample-transfer system with a three-sample parking stage and a sample preparation chamber. The sample preparation chamber contains four evaporators, an Ar sputter gun, a sample heater (up to 500 °C), a magnet (up to 1000 Oe), and a LEED system for sample analysis. The endstation is also equipped with an XMCD chamber that allows the acquisition of XMCD spectra in alternating magnetic fields (up to 750 Oe) without spatial resolution (spot size about 1 mm) for reference. ■



PEEM electron optics layout.

This branchline is available to independent investigators with the concurrence of the PRT.

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